SYSTEM AND METHOD FOR CLEARING AN IMPLANTED CATHETER THAT IS CONNECTED TO A SHUNT

FIELD OF THE INVENTION

The present invention relates generally to a shunt and a catheter having a system for clearing a blockage or obstruction of the catheter apertures.

BACKGROUND OF THE INVENTION

Hydrocephalus is a neurological condition that is caused by the abnormal accumulation of cerebrospinal fluid (CSF) within the ventricles, or cavities, of the brain. CSF is a clear, colorless fluid that is primarily produced by the choroid plexus and surrounds the brain and spinal cord. CSF constantly circulates through the ventricular system of the brain and is ultimately absorbed into the bloodstream. CSF aids in the protection of the brain and spinal cord. Because CSF keeps the brain and spinal cord buoyant, it acts as a protective cushion or "shock absorber" to prevent injuries to the central nervous system.

Hydrocephalus, which affects children and adults, arises when the normal drainage of CSF in the brain is blocked in some way. Such blockage can be caused by a number of factors, including, for example, genetic predisposition, intraventricular or intracranial hemorrhage, infections such as meningitis, head trauma, or the like. Blockage of the flow of CSF consequently creates an imbalance between the amount of CSF produced by the choroid plexus and the rate at which CSF is absorbed into the bloodstream, thereby increasing pressure on the brain, which causes the ventricles to enlarge.

Hydrocephalus is most often treated by surgically inserting a shunt system that diverts the flow of CSF from the ventricle to another area of the body where the CSF can be absorbed as part of the circulatory system. Shunt systems come in a variety of models, and typically share similar functional components. These components include a ventricular catheter which is introduced through a burr hole in the skull and implanted in the patient's ventricle, a drainage catheter that carries the CSF to its ultimate drainage site, and optionally a flow-control mechanism, e.g., shunt valve, that regulates the one-way flow of CSF from the ventricle to the drainage site to maintain normal pressure within the

ventricles. The ventricular catheter typically contains multiple holes or apertures positioned along the length of the ventricular catheter to allow the CSF to enter into the shunt system.

Shunting is considered one of the basic neurosurgical procedures, yet it has the highest complication rate. The most common complication with shunting is obstruction of the system. Although obstruction or clogging may occur at any point along the shunt system, it most frequently occurs at the ventricular end of the shunt system. While there are several ways that the ventricular catheter may become blocked or clogged, obstruction is typically caused by growth of tissue, such as the choroid plexus, around the catheter and into the apertures. The apertures of the ventricular catheter can also be obstructed by debris, bacteria, or coagulated blood.

Some of these problems can be treated by backflushing, which is a process that uses the CSF present in the shunt system to remove the obstructing matter. This process can be ineffective, however, due to the small size of the apertures of the ventricular catheter and due to the small amount of flushing liquid available in the shunt system. Other shunt systems have been designed to include a mechanism for flushing the shunt system. For example, some shunt systems include a pumping device within the system which causes fluid in the system to flow with considerable pressure and velocity, thereby flushing the system. As with the process of backflushing, using a built-in mechanism to flush the shunt system can also fail to remove the obstruction due to factors such as the size of the apertures and the degree and extent to which the apertures have been clogged.

Occluded ventricular catheters can also be repaired by cauterizing the catheter to remove blocking tissue, thereby reopening existing apertures that have become occluded. Alternatively, new apertures can be created in the catheter. These repairs, however, may be incapable of removing obstructions from the ventricular catheter depending on the location of the clogged apertures. Additionally, the extent of tissue growth into and around the catheter can also preclude the creation of additional apertures, for example, in situations where the tissue growth covers a substantial portion of the ventricular catheter. Another disadvantage of creating new apertures to repair an occluded ventricular catheter is that this method fails to prevent or reduce the risk of repeated obstructions.

Because attempts at flushing or repairing a blocked ventricular catheter are often futile and ineffective, occlusion is more often treated by replacing the catheter. Although this can be accomplished by removing the obstructed catheter from the ventricle, the growth of the choroid plexus and other tissues around the catheter and into the apertures can hinder removal and replacement of the catheter. Care must be exercised to avoid damage to the choroid plexus, which can cause severe injury to the patient, such as, for example, hemorrhaging. Not only do these procedures pose a significant risk of injury to the patient, they can also be very costly, especially when shunt obstruction is a recurring problem.

Accordingly, there exists a need for a shunt system that minimizes or eliminates the risk of blockage or obstruction of the catheter apertures, and reduces the need for repeated repair and/or replacement.

SUMMARY OF THE INVENTION

The present invention provides a shunt having a housing and a base. The base has a first set of electrodes extending across the base. A catheter is connected to the housing. The catheter has a longitudinal length, a proximal end, and a distal end. The catheter has a second set of electrodes extending along the longitudinal length of the catheter. At least two of the electrodes of said first set are electrically connected to two of the electrodes of the second set.

In another embodiment, the present invention provides a system for clearing an implanted catheter that is connected to a shunt. The system includes a housing having a base. The base has a first set of electrodes extending across the base. The housing including a self sealing, needle penetrable outer housing wall. A catheter is connected to the housing. The catheter has a longitudinal length, a proximal end, and a distal end. The catheter has a second set of electrodes extending along the longitudinal length of the catheter. At least two of the electrodes of the first set are electrically connected to two of the electrodes of the second set. The system includes a probe assembly that is selectively penetratable through the outer housing wall.

In yet another embodiment, the present invention provides a method of clearing an implanted catheter that is connected to a shunt. The method includes the steps of puncturing the outer wall, inserting a probe having a plurality of contacts at a distal end thereof into the socket such that the plurality of contacts contact the first set of electrodes,

providing bipolar electrosurgical power to the second set of electrodes via the plurality of contacts and the first set of electrodes, and clearing a fluid blockage in the catheter.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Figure 1 is a top perspective view of the shunt according to the present invention;

Figure 2 is a partial perspective view, with parts broken away, showing the interior of the shunt housing;

Figure 3 is a cross-sectional view taken along lines 3-3 of Figure 2 and looking in the direction of the arrows;

Figure 4 is a cross-sectional view taken along lines 4-4 of Figure 1 and looking in the direction of the arrows;

Figure 5 is a cross-sectional view taken along lines 5-5 of Figure 1 and looking in the direction of the arrows;

Figure 5A is cross-sectional view similar to Figure 5, but showing the electrodes partially protruding into an aperature;

Figure 6 is a partial perspective view of the electrodes;

Figure 7 is a partial perspective view of the probe;

Figure 8 is a bottom view of the probe;

Figure 9 is a partial perspective view of another embodiment of the probe;

Figure 10A is a partial cross-sectional view of the shunt housing showing the housing dome being penetrated by a needle and sheath assembly;

Figure 10B is a partial cross-sectional view of the shunt housing showing the housing dome being penetrated by the sheath with the needle being withdrawn; and

Figure 10C is a partial cross-sectional view of the shunt housing showing the housing dome being penetrated by the sheath and the probe being inserted into the housing.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Referring now to Figures 1-6, a shunt 10 is illustrated. Shunt 10 includes a housing 12 having a base 14. Base 14 has a first set of electrodes 16 extending across base 14. A catheter 18 is selectively connectable to housing 12. Catheter 18 has a longitudinal length, a proximal end 20, and a distal end 22. Catheter 18 has a second set of electrodes 24 extending along the longitudinal length of the catheter. Each of the electrodes of the first set 16 is electrically connected to a respective one of the electrodes of the second set 24 in a manner known to those skilled in the art. Preferably, the first set of electrodes and the second set of electrodes each include four electrodes.

As illustrated in Figures 1 and 4, the catheter proximal end 20 is connected to housing 12. The catheter distal end 22 is disposed remote from housing 12 and has a plurality of apertures 26 adjacent to the distal end to preferably receive cerebrospinal fluid (CSF) when in use. As illustrated in Figure 5A, a portion 28 of each of the electrodes of the second set 24 extends or projects into at least one of the plurality of apertures 26. Portion 28 is relatively small with respect to the size of aperture 26, so as not to interfere with the normal function of the shunt. At least a first one of the electrodes of the second set 24 extends into a first one of the plurality of apertures 26, and at least a second one of the electrodes of the second set 24 extends into a second one of the plurality of apertures, such that the first one of the plurality of apertures is disposed approximately diametrically opposed to the second one of the plurality of apertures. Thus, the catheter lumen can be cleared when both of these electrodes are activated.

In addition, at least a first one of the electrodes of the second set 24 extends into a first one of the plurality of apertures, and at least a second one of the electrodes of the second set 24 extends into the same first one of the plurality of apertures, but preferably diametrically opposed to the first one of the plurality of electrodes as illustrated in Figure 5A. Thus, the aperture itself can be cleared when both of these electrodes are activated. Preferably, an electrode projects into each of the apertures, or substantially all of the apertures so that the catheter can be effectively cleared of any blockage.

The shunt housing 12 further includes a self-sealing, needle penetrable outer housing wall 30. Housing 12 further includes a socket 32 for receiving a probe 42. The first set of electrodes 16 extends at least partially through a base of socket 32. The first set of electrodes has a first end 36 that terminate in the base of the socket. Socket 32 is illustrated as having an internal double D-shaped cross-section so that it can only mate with probe 42 in one of two positions. However, the probe and socket can have any

correspondingly mating geometric shape to ensure the desired orientation and alignment of the contacts at the distal end of the probe (to be described below) with the respective electrodes of the first set of electrodes.

As illustrated in Figures 10A-10C, the probe assembly 34 is selectively penetrable through the outer housing wall 30, which is preferably dome-shaped. Probe assembly 34 includes a sleeve or sheath 38, a retractable needle 40, and a retractable probe 42. To insert the probe assembly into the housing 12, needle 40, which is within sheath 38, initially penetrates wall 30 until sheath 38 is in sealing contact with wall 30, as illustrated in Figure 10A. Needle 40 is then withdrawn from sheath 38, as illustrated in Figure 10B. Probe 42 is then inserted within sheath 38 until the distal end 44 of probe 42 is matingly received within socket 32. As illustrated in Figures 7 and 8, the distal end 44 of probe 42 has a four contacts 46, each of which contacts one of the electrodes 16 of the first set of electrodes to close the circuit from the probe assembly to the electrodes in the second set of electrodes. As illustrated in Figure 9, probe 42 may include only two contacts at its distal end 44. The contacts 46 are preferably resiliently biased in the distal direction to ensure contact with electrodes 16.

Once the probe 42 has been fully inserted into the housing 12 such that the contacts 46 are in contact with the electrodes 16, bipolar electrosurgical power from an electrosurgical generator can then be provided to the second set of electrodes 24 via the plurality of contacts 46 and the first set of electrodes 16. Referring now to Figure 5A, the bipolar power can be applied to any two of the electrodes 24 such that any two of the four portions 28 are sufficiently charged to cause an arc there across, which can clear a fluid blockage in the catheter 18. For example, the arc can be created across the aperture 26, as illustrated by dashed lines 48, to clear a blockage occurring in the aperture. Additionally, the arc can be created across the catheter lumen, as illustrated by dashed lines 50, to clear a blockage occurring within the lumen. Preferably, both the aperture and the lumen will be charged with bipolar electrosurgical power to ensure that the blockage within the catheter has been cleared. However, depending upon the needs of the surgeon, only selective apertures and/or the lumen may be cleared. One skilled in the art will readily recognize that this can simply be accomplished with appropriate switches connected to the electrosurgical generator.

It will be understood that the foregoing is only illustrative of the principles of the invention, and that various modifications can be made by those skilled in the art without

departing from the scope and spirit of the invention. All references cited herein are expressly incorporated by reference in their entirety.

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